Italian Botanist 18: 225–243 (2024)
doi: 10.3897/italianbotanist.18.143739
https://italianbotanist.pensoft.net

RESEARCH ARTICLE

Italian Botanist
Published by Società Botanica Italiana

Contribution to the knowledge of the bryophyte flora of the Lucanian side of the Pollino National Park

Michele Aleffi[1], Annalena Cogoni[2], Carmine Colacino[3], Enza Evangelista[3], Sandro Perego[4], Maria Privitera[5], Marta Puglisi[5], Domenico Puntillo[6], Francesco Sguazzin[7], Roberta Tacchi[1], Silvia Poponessi[8]

1 *School of Biosciences and Veterinary Medicine, Plant Diversity & Ecosystems Management Unit, Bryology Laboratory & Herbarium, University of Camerino, Camerino (MC), Italy* **2** *Department of Life and Environmental Sciences, Botany section, University of Cagliari, Cagliari, Italy* **3** *School of Agricultural, Forestry, Food and Environmental Sciences - SAFE, University of Basilicata, Potenza, Italy* **4** *Via Emilio Cecchi 1, Milano, Italy* **5** *Department of Biological, Geological and Environmental Sciences, University of Catania, Catania, Italy* **6** *Museum of Natural History and Botanic Garden, University of Calabria, Loc. Polifunzionale, Arcavacata di Rende (CS), Italy* **7** *Via Selvotta 61, Muzzana del Turgnano (UD), Italy* **8** *Institute for Alpine Environmental, Eurac Research, Viale Druso 1, Bozen, Italy*

Corresponding author: Michele Aleffi (michele.aleffi@unicam.it)

Academic editor: Lorenzo Peruzzi | **Received** 6 December 2024 | **Accepted** 13 December 2024 | **Published** 20 December 2024

Citation: Aleffi M, Cogoni A, Colacino C, Evangelista E, Perego S, Privitera M, Puglisi M, Puntillo D, Sguazzin F, Tacchi R, Poponessi S (2024) Contribution to the knowledge of the bryophyte flora of the Lucanian side of the Pollino National Park. Italian Botanist 18: 225–243. https://doi.org/10.3897/italianbotanist.18.143739

Abstract

The findings of the Bryological Excursion conducted by the Working Group for Bryology of the Italian Botanical Society from 5 to 8 July 2012 on the Lucanian side of the Pollino National Park are presented herein. The objective of the excursion was to address the paucity of knowledge regarding bryological diversity in understudied regions of Italy. This endeavour led to the discovery of 150 species of bryophytes, 41 of which are novel to the Basilicata region. For each species, the collection location and growth substrate are indicated. Some of the species are of floristic and phytogeographic interest. This is a group of boreal and arctic-alpine species, previously documented only in the Alpine arc and at the highest peaks of the Apennine chain. The Pollino massif represents the southernmost limit of their range. It is worth noting the presence of *Brachydontium trichodes*, *Schistidium papillosum*, *Tortula laureri* and *Herzogiella striatella*. Another noteworthy assemblage of species is found on the ophiolitic rocks of Timpa delle Murge. The distinctive ecological characteristics of this substrate result in the evolution of species that are exclusive to these environments. The ecological characteristics and distribution of each species within these two groups are described in detail.

Keywords

Biodiversity, bryophytes, chorology, floristic novelties, Pollino massif

Copyright *Michele Aleffi et al.* This is an open access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Introduction

The Pollino massif represents the highest mountain range of the Southern Apennines, situated in Italy between the Basilicata and Calabria regions. This mountain range constitutes, along with the Verbicaro-Orsomarso mountains, part of the Pollino National Park, which, with an area of 1,930 km², is the largest national park in Italy. The protected area was established primarily to protect the rare *Pinus leucodermis* Antoine species (Fig. 1), which is characteristic of the mountain peaks and has been documented to exceed one hundred years of age and reach heights of up to 40 meters (Avolio 1996).

In addition to this species, the Pollino National Park exhibits several other distinctive floristic features as a result of its geographical location, which allows for the formation of a range of different biogeographical links. The biogeographical relation with the southern Balkan district is undoubtedly the most evident, as evidenced by the occurrence of a considerable number of amphi-adriatic species, including *Pinus leucodermis* Antoine and *Festuca bosniaca* Kumm. Furthermore, the following species have been identified: *Carex kitaibeliana* Degen ex Beck, *Edrajanthus graminifolius* (L.) A.DC. ex Meisn., *Sesleria autumnalis* (Scop.) F.W. Schultz, *Gentianella crispata* (Vis.) Holub, *Cytisus spinescens* Presl, and other species frequently exert a significant influence on the vegetational pattern (Bonin 1969, 1972). Concurrently, the Pollino massif represents the southernmost limit for various boreal or arctic-alpine species, including *Orthilia secunda* (L.) House, *Pyrola minor* L., *Chrysosplenium dubium* J.Gay ex Ser., *Saxifraga aizoides* L., and *Carex pallescens* L. Additionally, species such as *Carex vesicaria* L., *Senecio alpinus* (L.) Scop.,

Figure 1. *Pinus leucodermis* Antoine in the Serra di Crispo (2050 m a.s.l.).

and others, which were distributed across the Italian Peninsula during the ice ages, persisted as isolated relicts in the postglacial period (Bernardo 1995; Bernardo et al. 2000).

Regarding the vegetation, it can be observed that above 800 m a.s.l. and up to 1100 m a.s.l. in the supramediterranean belt, forests of deciduous trees are present, with the most common species being *Quercus pubescens* Willd., *Q. cerris* L., *Q. frainetto* Ten., often mixed with *Carpinus orientalis* Mill., *Castanea sativa* Mill., and *Alnus cordata* (Loisel.) Duby. It is noteworthy that *Fagus sylvatica* L. can grow alongside *Abies alba* Mill. in the Pollino massif. Up to approximately 1500 m a.s.l., the Anemono apenninae-Fagetum (Gentile 1970) Brullo 1983 (Di Pietro 2009) association can be observed. Above the tree limit, the dry grasslands of the alliance Seslerion apenninae Furnari in Bruno and Furnari (1966) (Di Pietro 2010) are found. The presence of *Pinus leucodermis* serves to distinguish and define the unique mountain and high-mountain vegetation of the park. This species is found in isolated or small populations, climbing rough rock walls and exhibiting resilience to strong winds.

From a geological perspective, the Pollino massif is predominantly composed of Meso-Cenozoic limestone rocks of sedimentary origin, with outcrops of ophiolitic rocks (basalt vulcanites) characterising the Timpa della Murge and the Timpa di Pietrassasso. The Orsomarso mountains exhibit a geology that is analogous to that of the Pollino massif. The pervasive occurrence of limestone gives rise to the prevalence of karst phenomena, including sinkholes, caves, subterranean rivers, and striking geological features such as canyons (Bonardi et al. 1988).

In terms of the bioclimate, the mountainous region is characterized by a temperate-oceanic bioclimate with an orotemperate thermotype and hyperhumid umbrotype at elevations above 1500 m a.s.l. Additionally, a temperate-Mediterranean transition climate is observed at elevations between 1000 m and 1500 m a.s.l., characterised by a supratemperate thermotype and humid umbrotype (Blasi 2006).

Despite the notable botanical interest of the massif, the bryophyte flora of this mountain system in particular and of the Basilicata Region in general remains relatively understudied. In fact, most of the reports are derived from a limited number of incomplete studies dating from the late 19th and early 20th centuries (Pasquale 1850; Giordano 1871, 1879, 1892; Bottini et al. 1883; Brizi 1890; Bottini 1894; Micheletti 1895; Bottini 1909; Zodda 1909, 1910, 1913; Cavara and Grande 1913; Gavioli 1934; Giacomini 1938); the most recent contributions to the knowledge of the bryoflora of the Pollino massif were made by: Puglisi et al. (2009) with the report of *Calliergon cordifolium* (Hedw.) Kindb., *Marchantia polymorpha* subsp. *montivagans* Bischl. & Boisselier and *Marchantia polymorpha* L. subsp. *polymorpha*; Puglisi et al. (2014) with the report of *Orthotrichum cupulatum* Hoffm. ex Brid. var. *fuscum* (Venturi) Boulay, *Schistidium dupretii* (Thér.) W.A.Weber, *Distichium inclinatum* (Hedw.) Bruch & Schimp., *Grimmia longirostris* Hook and *Orthotrichum acuminatum* H.Philib.; Puglisi et al. (2016a) (2016b) that they report *Mnium spinosum* (Voit) Schwägr., *Brachythecium tommasinii* (Sendtn. ex Boulay) Ignatov & Huttunen, *Campylidium sommerfeltii* (Myrin) Ochyra, *Grimmia laevigata* (Brid.) Brid., *G. montana* Bruch & Schimp., *G. tergestina* Tomm. ex Bruch & Schimp., *G. trichophylla* Grev. and *Orthotrichum pumilum* Sw.; and finally Puglisi and Privitera (2018) with the report of *Anomodon rugelii* (Müll.Hal.) Keissl.

The most complete research carried out recently for the entire region is that by Colacino et al. (2013) which reports 55 new taxa (47 mosses and 8 liverworts) for Basilicata Region and 90 confirmations of taxa (85 mosses and 5 liverworts) reported before 1950. Nevertheless, the most recent checklist by Aleffi et al. (2023) documents for the Basilicata Region only 272 taxa (232 mosses and 40 liverworts), which represents, together with Molise, the Italian region with the lowest number of reported taxa.

The annual excursion of the Working Group for Bryology of the Italian Botanical Society was conducted precisely on the Lucanian side of the Pollino massif. The aim was to fill in the gaps existing in some areas of the Lucanian territory that are little explored and little known from a bryological point of view. The excursion highlighted the presence in the explored area of some remarkable mosses, which merit special consideration both from a floristic and a biogeographical point of view.

Study area

The study area is situated within the Basilicata region, at an altitude ranging between 950 and approximately 2000 meters above sea level. The excursion entailed an exploration of the beech forests situated in the Acqua Tremola locality (Terranova del Pollino, loc. Case del Conte), after which the route continued towards Serra di Crispo-Grande Porta del Pollino. This area is included in the SCI IT9210245, which encompasses Serra di Crispo, Grande Porta del Pollino, and Pietra Castello. From the Grande Porta (1957 m a.s.l.), the route continues in a northerly direction towards Serra di Crispo (2053 m a.s.l.). This area is notable for its so-called 'Garden of the Gods', which contains majestic, centuries-old specimens of *Pinus leucodermis*. In this area, the vegetation, which is strongly influenced by the wind, consists of high-altitude grasslands and scattered shrub vegetation, characterised by krummholz of *Juniperus nana* Willd. and *J. hemisphaerica* J. & C. Presl. (Fig. 2).

From Grande Porta we descended towards Piani di Pollino and then towards Lago Fondo (1508 m) and Lago Duglia (1375 m), small lakes that vary in size depending on the season, passing Pietra Castello (1671 m) and crossing beech-abetine woods with *Abies alba*. The second part of the excursion focused on the Fosso Jannace gorge, a canyon characterised by several areas of beech, fir and monumental maple trees, as well as the presence of several wetlands and waterfalls, and then climbed towards the La Catusa spring (Fig. 3) and the Frido stream to study the riparian vegetation. Finally, at Timpa delle Murge, several areas with outcrops of ophiolitic rocks (basalt volcanites) and Mediterranean vegetation with *Ilex aquifolium* L. were explored.

Materials and methods

Identification of bryophytes was based on Cortini Pedrotti (2001, 2005), Smith (2004) and Casas et al. (2006) for mosses; Smith (1991), Paton (1999) and Casas et al. (2009) for liverworts. The nomenclature follows Hodgetts et al. (2020). Species

Figure 2. In the foreground krummholz of *Juniperus nana* Willd. and *J. hemisphaerica* J. & C.Presl.

Figure 3. Beech forest and rochy outcrops in the La Catusa spring area.

distributions follow Aleffi et al. (2023). Taxa are listed in alphabetical order with the locality, habitat of collection and the Italian IUCN Threat Category (Puglisi et al. 2023, 2024). The specimens are kept in the herbaria of the participants of the excursion. Taxa new to Basilicata are indicated with an asterisk (*), while a cross (+) marks taxa reported before 1968. The bryophyte flora was studied in the following areas (Fig. 4):

1. Acqua Tremola (Loc. Case del Conte) (1474 m a.s.l.) 39°58'02.2"N, 16°13'01.1"E.
2. Acqua Tremola trail towards Serra di Crispo (1700 m a.s.l.) 39°57'41.3"N, 16°12'40.9"E.
3. *Pitt'accurc'* source, under Serra di Crispo (1846 m a.s.l.) 39°55'58"N, 16°12'20"E.
4. Under Piano Iannace (1650 m a.s.l.) 39°56'41.55"N, 16°11'43.87"E.
5. Piano Jannace (1926 m a.s.l.) 39°55'52"N, 16°12'36.3"E.
6. Serra di Crispo (1985 m a.s.l.) 39°55'55.5"N, 16°12'43.3"E.
7. Serra di Crispo (2050 m a.s.l.) 39°56'06"N, 16°12'40"E.
8. Pietra Castello trail towards Lago Fondo (1876 m a.s.l.) 39°56'40"N, 16°12'57"E.
9. Piano S. Francesco (1500 m a.s.l.) 39°57'15"N, 16°12'18"E.
10. Lago Fondo (1500 m a.s.l.) 39°56'46"N, 16°13'38"E.
11. Serretta della Porticella (1985 m a.s.l.) 39°56'17"N, 16°12'28"E.
12. Fontana Rummo (1720 m a.s.l.) 39°55'12"N, 16°11'24"E.
13. Piano di Vacquarro (1480 m a.s.l.) 39°55'29"N, 16°10'34"E.
14. Lago Duglia (1375 m a.s.l.) 39°56'58"N, 16°13'58"E.
15. Lago Duglia (old sawmill) (1387 m a.s.l.) 39°56'54"N, 16°14'42"E.
16. Frido torrent, Mezzana Salice Conocchielle (947 m a.s.l.) 39°58'45"N, 16°10'23"E.
17. Municipal road of San Severino Lucano 39°57'55"N, 16°11'48"E.
18. Timpa delle Murge (between Case del Conte and La Catusa source) (1216 m a.s.l.) 39°58'47"N, 16°15'10"E.
19. La Catusa source, San Giorgio Lucano (1300 m a.s.l.) 39°59'16"N, 16°14'26"E.

Results

The research carried out in the Lucanian part of the Pollino National Park led to the identification of 150 bryophyte taxa (14 liverworts and 136 mosses). According to the Checklist of Italian Bryophytes (Aleffi et al. 2023), 2 liverworts and 39 mosses are new to Basilicata, while 10 other moss taxa recorded before 1968 were confirmed for the region. The list of bryophytes collected during this research is presented below, with an indication of the location and collection environment.

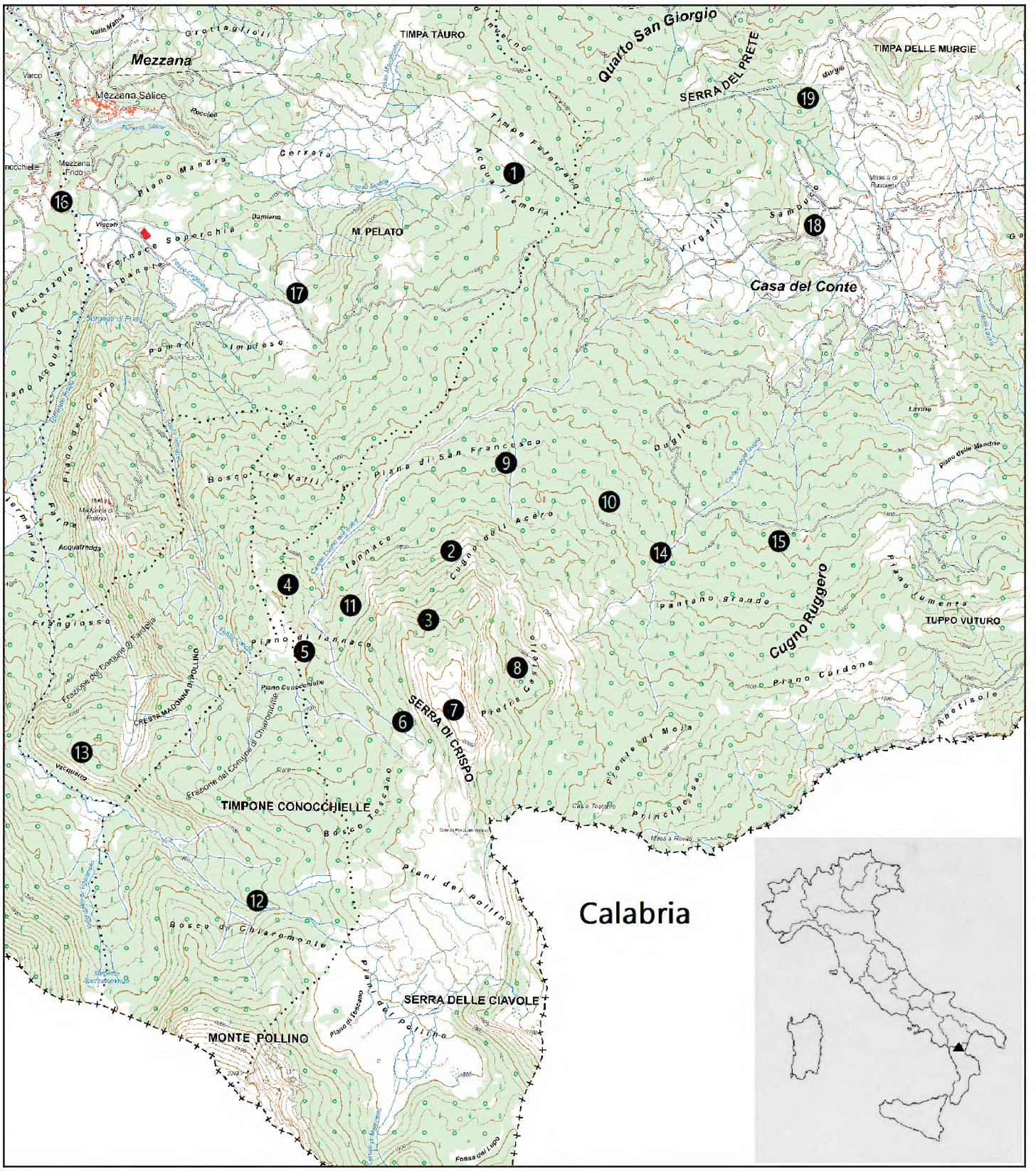

Figure 4. Map of the study area showing the collection sites.

List of taxa

Liverworts

**Cephaloziella baumgartneri* Schiffn.: on stump of *Fagus sylvatica* (8) (LC).
Frullania dilatata (L.) Dumort.: on bark of *Fagus sylvatica* (14, 15) and *Populus alba* (16) (LC).
Lophocolea bidentata (L.) Dumort.: on soil along the river (15) (LC).
Marchantia polymorpha L. subsp. *polymorpha*: on damp soil near the fountain (13) (LC).

Metzgeria furcata (L.) Corda: on bark of *Fagus sylvatica* (1, 15) (LC).
**Pellia epiphylla* (L.) Corda subsp. *epiphylla*: on ophiolitic rocks (18) (LC).
Plagiochila asplenioides (L.) Dumort.: on rocks (8, 12) (LC).
Plagiochila porelloides (Torr. ex Nees) Lindenb. var. *porelloides*: on rocks below *Pinus leucodermis* (7); on rocks (19) (LC).
Porella cordeana (Huebener) Moore: on rocks (11) (LC).
Porella platyphylla (L.) Pfeiff.: on bark of *Fagus sylvatica* (1); on rocks (5, 15); on soil (14); on stump of *Fagus sylvatica* (15) (LC).
Radula complanata (L.) Dumort.: on bark of *Fagus sylvatica* (1, 14, 15) and *Populus alba* (16); on rocks (5, 19); on stump of *Fagus sylvatica* (15) (LC).
Radula lindenbergiana Gottsche ex C.Hartm.: on rocks (8) (LC).
Reboulia hemispherica (L.) Raddi subsp. *hemisphaerica*: on damp soil (16) (LC).
Solenostoma gracillimum (Sm.) R.M.Schust.: on rocks below *Pinus leucodermis* (7) (LC).

Mosses

**Bartramia ithyphylla* Brid.: on rocks (11) (LC).
**Brachydontium trichodes* (F.Weber) Milde: on soil (14) (EN).
Brachytheciastrum velutinum (Hedw.) Ignatov & Huttunen: on calcareous rocks (2, 8); on soil near the river (8); on stump of *Fagus sylvatica* (8, 15) (LC).
+*Brachythecium albicans* (Hedw.) Schimp.: on soil and on rocks (5) (LC).
**Brachythecium cirrosum* (Schwägr.) Schimp.: on soil (29) (LC).
**Brachythecium mildeanum* (Schimp.) Schimp.: on soil near the river (8) (LC).
Brachythecium rivulare Schimp.: on damp soil and rocks near the river (8, 13, 15, 19) (LC).
Brachythecium rutabulum (Hedw.) Schimp.: on soil near the river (15, 16, 19) (LC).
Brachythecium salebrosum (Hoffm. ex F.Weber & D.Mohr) Schimp.: on stump of *Fagus sylvatica* (8); on bark of *Populus alba* (16) (LC).
Brachythecium tommasinii (Sendtn. ex Boulay) Ignatov & Huttunen: on damp rocks (4, 5, 19) (LC).
+*Bryoerythrophyllum recurvirostrum* (Hedw.) P.C.Chen: on soil (2, 6) (LC).
Bryum canariense Brid.: on bark of *Fagus sylvatica* (1); on ophiolitic rocks (18) (LC).
Bryum dichotomum Hedw.: on calcareous (3) and ophiolitic rocks (18) (LC).
Calliergonella cuspidata (Hedw.) Loeske: on damp soil near the fountain (13) (LC).
Ceratodon purpureus (Hedw.) Brid. subsp. *purpureus*: on soil (6, 17); on ophiolitic rocks (18) (LC).
Cirriphyllum crassinervium (Taylor) Loeske & M. Fleisch.: on soil (14) (LC).
Cratoneuron filicinum (Hedw.) Spruce: on rocks (8, 19) and on soil near the river (8, 16) (LC).
Ctenidium molluscum (Hedw.) Mitt.: on rocks (5) (LC).
**Dichodontium pellucidum* (Hedw.) Schimp.: on rocks (5) (LC).
Dicranella heteromalla (Hedw.) Schimp.: on bark of *Pinus leucodermis* (7); on stump of *Fagus sylvatica* (15); on soil (14, 15) (LC).
+*Dicranum scoparium* Hedw.: on soil (2, 13, 15); on rocks (11) (LC).

**Dicranum tauricum* Sapjegin: on stump of *Fagus sylvatica* (8); on rocks (12); on soil (15) (LC).
Distichium capillaceum (Hedw.) Bruch & Schimp.; on rocks (5, 7); on soil (6) (LC).
Ditrichum heteromallum (Hedw.) E.Britton: on soil (14) (LC).
**Ditrichum pusillum* (Hedw.) Hampe: on rocks (8) (LC).
**Drepanocladus aduncus* (Hedw.) Warnst.: on damp soil near the fountain (13) (LC).
Encalypta streptocarpa Hedw.: on soil (2, 6); on rocks (7, 10, 12) (LC).
Encalypta vulgaris Hedw.: on rocks (3); on soil (6) (LC).
**Enthostodon obtusum* (Hedw.) Lindb.: on soil (14) (LC).
Eucladium verticillatum (With.) Bruch & Schimp.: on damp soil (16) (LC).
Eurhynchiastrum pulchellum (Hedw.) Ignatov & Huttunen: on bark of *Fagus sylvatica* (15) and *Populus alba* (16) (LC).
Exsertotheca crispa (Hedw.) S.Olsson, Enroth & D.Quandt: on rocks (5) (LC).
Fissidens dubius P.Beauv. var. *dubius*: on rocks (2) (LC).
**Fissidens serrulatus* Brid.: on rocks (2) (LC).
Fissidens taxifolius Hedw.: on rocks (12); on damp soil (15) (LC).
Flexitrichum flexicaule (Schwägr.) Ignatov & Fedosov: on rocks (11, 12) (LC).
Geheebia lurida (Hornsch.) J.A. Jiménez & M.J.Cano: on soil (6) (LC).
**Grimmia alpestris* (F.Weber & D.Mohr) Schleich.: on ophiolitic rocks (18) (VU).
Grimmia anodon Bruch & Schimp.: on ophiolitic rocks (18) (LC).
+Grimmia decipiens (Schultz) Lindb.: on ophiolitic rocks (18) (LC).
**Grimmia funalis* (Schwägr.) Bruch & Schimp.: on ophiolitic rocks (18) (LC).
Grimmia laevigata (Brid.) Brid.: on rocks (5) (LC).
Grimmia longirostris Hook.: on ophiolitic rocks (18) (LC).
Grimmia montana Bruch & Schimp.: on rocks (5); on ophiolitic rocks (18) (LC).
Grimmia ovalis (Hedw.) Lindb.: on rocks (5); on ophiolitic rocks (18) (LC).
Grimmia pulvinata (Hedw.) Sm.: on rocks (3); on ophiolitic rocks (18) (LC).
Grimmia tergestina Tomm. ex Bruch & Schimp.: on ophiolitic rocks (18) (NT).
Grimmia trichophylla Grev.: on rocks (5); on ophiolitic rocks (18); on damp soil (16) (LC).
Habrodon perpusillus (De Not.) Lindb.: on rocks (7); on bark of *Fagus sylvatica* (14) (LC).
Hedwigia ciliata (Hedw.) P.Beauv.: on ophiolitic rocks (18) (LC).
**Hedwigia emodica* Hampe *ex* Müll.Hal.: on ophiolitic rocks (18) (LC).
**Herzogiella striatella* (Brid.) Z.Iwats.: on stump of *Fagus sylvatica* (8) (DD).
**Heterocladium heteropterum* (Brid.) Schimp.: on rocks (11) (LC).
Homalothecium lutescens (Hedw.) H.Rob. var. *lutescens*: on damp soil (16) (LC).
Homalothecium philippeanum (Spruce) Schimp.: on rocks (4, 5 19); on soil (17) (LC).
Homalothecium sericeum (Hedw.) Schimp.: on bark of *Fagus sylvatica* (1, 14) and *Populus alba* (16); on stump of *Fagus sylvatica* (15); on soil (2); on rocks (2, 5, 7, 10, 12, 19); on ophiolitic rocks (18) (LC).
**Homomallium incurvatum* (Schrad. ex Brid.) Loeske: on soil near the river (15) (LC).
Husnotiella sinuosa (Mitt.) J.A.Jiménez & M.J.Cano: on rocks (19) (LC).
+Hygroamblystegium tenax (Hedw.) Jenn.: on damp soil (8, 16) (LC).
**Hypnum andoi* A.J.E.Sm.: on soil (6) (LC).

Hypnum cupressiforme Hedw. var. *cupressiforme*: on bark of *Fagus sylvatica* (2, 14) and *Populus alba* (16); on soil (15) and rocks (19) near the river; on ophiolitic rocks (18) (LC).
Hypnum cupressiforme Hedw. var. *lacunosum* Brid.: on bark of *Pinus leucodermis* (7) (LC).
**Isopterygiopsis pulchella* (Hedw.) Z.Iwats.: on stump of *Fagus sylvatica* (15) (LC).
Isothecium alopecuroides (Lam. ex Dubois) Isov.: on soil (2) and rocks (15, 19) (LC).
Lescuraea incurvata (Hedw.) E.Lawton: on soil (2) and rocks (2, 3, 4, 5, 9, 12, 19); on bark of *Fagus sylvatica* (2, 5, 15), *Pinus leucodermis* (7) and *Abies alba* (9) (LC).
**Lescuraea plicata* (Schleich. *ex* F.Weber & D.Mohr) Broth.: on soil near the river (8) (LC).
**Lescuraea saviana* (De Not.) E.Lawton: on bark of *Pinus leucodermis* (7) (DD).
Leucodon sciuroides (Hedw.) Schwägr.: on bark of *Fagus sylvatica* (1, 5, 9, 10, 14), *Abies alba* (9) and *Populus alba* (16); on rocks (5); on ophiolitic rocks (18) (LC).
Lewinskya affinis (Schrad. ex Brid.) F.Lara, Garilleti & Goffinet: on bark of *Fagus sylvatica* (5, 14, 15) and *Populus alba* (16); on rocks (15, 19) (LC).
Lewinskya rupestris (Schleich. ex Schwägr.) Lara, Garilleti & Goffinet: on bark of *Fagus sylvatica* (1); on rocks (3, 4, 5, 12, 19); on ophiolitic rocks (18) (LC).
Lewinskya shawii (Wilson) F.Lara, Garilleti & Goffinet: on bark of *Fagus sylvatica* (9, 15) and *Abies alba* (9); on rocks (11) (NT).
Lewinskya speciosa (Nees) F.Lara, Garilleti & Goffinet: on rocks (2, 15); on bark of *Fagus sylvatica* (14, 15) (LC).
Lewinskya striata (Hedw.) F.Lara, Garilleti & Goffinet: on bark of *Fagus sylvatica* (1, 2, 5, 14) (LC).
**Microeurhynchium pumilum* (Wilson) Ignatov & Vanderp.: on rocks (19) (LC).
Mnium stellare Hedw.: on rocks (19) (LC).
Neckera menziesii Drumm.: on rocks (4, 19) (LC).
**Neckera pumila* Hedw.: on rocks (19) (LC).
Nogopterium gracile (Hedw.) Crosby & W.R.Buck: on bark of *Fagus sylvatica* (14); on rocks (19) (LC).
Orthotrichum cupulatum Brid. var. *cupulatum*: on rocks (2, 3, 5); on bark of *Fagus sylvatica* (9), *Abies alba* (9) and *Populus alba* (16) (LC).
Orthotrichum pallens Bruch ex Brid.: on bark of *Fagus sylvatica* (14) (LC).
Orthotrichum pumilum Sw. ex anon.: on bark of *Fagus sylvatica* (5) (LC).
Orthotrichum stramineum Hornsch. ex Brid.: on bark of *Fagus sylvatica* (1, 5, 14, 15); on rocks (15) (LC).
+*Palustriella commutata* (Hedw.) Ochyra: on damp soil (8, 17); on rocks (11, 19) (LC).
Palustriella falcata (Brid.) Hedenäs: on damp soil (8) and rocks (19) (LC).
**Pohlia cruda* (Hedw.) Lindb.: on rocs (12) (LC).
**Pohlia lescuriana* (Sull.) Ochi: on soil near the river (8) (LC).
Pohlia wahlenbergii (F.Weber & D.Mohr) A.L.Andrews var. *wahlenbergii*: on soil near the river (8, 13) (LC).
**Polytrichastrum alpinum* (Hedw.) G.L.Sm.: on rocks (7) (LC).
Polytrichum juniperinum Hedw.: on soil (5, 13); on ophiolitic rocks (18) (LC).
**Polytrichum piliferum* Hedw.: on ophiolitic rocks (18) (LC).

**Pseudoleskeella catenulata* (Brid. ex Schrad.) Kindb.: on rocks (5) (LC).
Pseudoleskeella nervosa (Brid.) Nyholm: on bark (2) and stump (8) of *Fagus sylvatica*; on rocks (4, 7, 8, 19) (LC).
Pterigynandrum filiforme Hedw.: on bark of *Fagus sylvatica* (1, 2, 9, 14, 15), *Pinus leucodermis* (7) and *Abies alba* (9); on rocks (12, 19) (LC).
Ptychostomum capillare (Hedw.) Holyoak & N.Pedersen: on rocks (4, 5, 8); on damp soil along the river (15, 16, 19); on ophiolitic rocks (18) (LC).
Ptychostomum elegans (Nees) D.Bell & Holyoak: on rocks (8) (LC).
Ptychostomum imbricatulum (Müll.Hal.) Holyoak & N.Pedersen: on soil (6) (LC).
**Ptychostomum inclinatum* (Sw. *ex* Brid.) J.R.Spence: on ophiolitic rocks (18) (LC).
Ptychostomum pallens (Sw. *ex* anon.) J.R.Spence: on bark of *Fagus sylvatica* (14, 15); on rocks (4) and soil (14); on ophiolitic rocks (18) (LC).
Ptychostomum schleicheri (DC.) J.R.Spence ex D.Bell & Holyoak var. *schleicheri*: on damp soil (2, 8) and rocks (5) (LC).
+Ptychostomum torquescens (Bruch & Schimp.) Ros & Mazimpaka: on damp soil near the river (8, 15, 16); on ophiolitic rocks (18) (LC).
**Ptychostomum turbinatum* (Hedw.) J.R.Spence: on rocks (5) (LC).
Pulvigera lyellii (Hook. & Taylor) Plášek, Sawicki & Ochyra: on bark of *Fagus sylvatica* (10, 14) and *Populus alba* (16) (LC).
+Racomitrium canescens (Hedw.) Brid. subsp. *canescens*: on soil (17); on ophiolitic rocks (18) (LC).
**Rhizomnium magnifolium* (Horik.) T.J.Kop.: on soil along the river (15) (LC).
+Rhizomnium punctatum (Hedw.) T.J.Kop. var. *punctatum*: on soil along the river and on stump of *Fagus sylvatica* (15) (LC).
**Rhynchostegiella litorea* (De Not.) Limpr.: on soil (14) (LC).
Rhynchostegium megapolitanum (Blandow ex F.Weber & D.Mohr) Schimp.: on soil (14) (LC).
Rhynchostegium murale (Hedw.) Schimp.: on soil (17) (LC).
Rhynchostegium riparioides (Hedw.) Cardot: on damp soil along the river (14, 16, 17, 19) (LC).
**Sanionia uncinata* (Hedw.) Loeske: on rocks (7, 8) (LC).
Schistidium apocarpum (Hedw.) Bruch. & Schimp.: on rocks (5, 12); on ophiolitic rocks (18) (LC).
Schistidium atrofuscum (Schimp.) Limpr.: on rocks (3, 7) (LC).
**Schistidium confertum* (Funk) Bruch & Schimp.: on rocks (2, 8, 10, 15); on soil (6, 16) (LC).
Schistidium crassipilum H.H.Blom.: on soil along the river (16); on ophiolitic rocks (18) (LC).
**Schistidium papillosum* Culm.: on ophiolitic rocks (18) (VU).
Schistidium rivulare (Brid.) Podp.: on rocks (5) (LC).
**Sciuro-hypnum starkei* (Brid.) Ignatov & Huttunen: on rocks (5) (LC).
Syntrichia laevipila Brid.: on bark of *Populus alba* (16) (LC).
Syntrichia montana Nees var. *montana*: on soil (7, 16); on ophiolitic rocks (18) (LC).

Syntrichia norvegica F.Weber: on rocks (3) (LC).
Syntrichia ruraliformis (Besch.) Mans.: on rocks (2); on ophiolitic rocks (18) (LC).
Syntrichia ruralis (Hedw.) F.Weber & D.Mohr var. *ruralis*: on soil (2, 6, 15); on rocks (2, 3, 4, 5, 7, 12, 19); on bark of *Fagus sylvatica* (5, 15) and *Populus alba* (16); on ophiolitic rocks (18) (LC).
Thamnobryum alopecurum (Hedw.) Gangulee: on rocks (19); on ophiolitic rocks (18) (LC).
+*Timmia austriaca* Hedw.: on rocks (8) (LC).
**Timmia norvegica* J.E.Zetterst.: on rocks (7) (LC).
**Tortella fragilis* (Drumm.) Limpr.: on soil (6); on ophiolitic rocks (18) (LC).
Tortella nitida (Lindb.) Broth.: on ophiolitic rocks (18) (LC).
Tortella squarrosa (Brid.) Limpr.: on rocks (4); on ophiolitic rocks (18) (LC).
Tortella tortuosa (Hedw.) Limpr.: on rocks (2, 4, 5, 7, 8, 10, 12); on ophiolitic rocks (18) (LC).
Tortula inermis (Brid.) Mont.: on stump of *Fagus sylvatica* (15) (LC).
**Tortula laureri* (Schultz) Lindb.: on rocks (5) (DD).
Tortula muralis Hedw. subsp. *muralis* var. *muralis*: on ophiolitic rocks (18) (LC).
Tortula subulata Hedw.: on soil (2, 14); on rocks (2, 3, 12); on ophiolitic rocks (18) (LC).
**Trichostomopsis australasiae* (Hook. & Grev.) H.Rob.: on soil (6) (LC).
Vinealobryum insulanum (De Not.) R.H.Zander: on rocks (19); on ophiolitic rocks (18) (LC).
Zygodon rupestris Schimp. ex Lorentz: on bark of *Populus alba* (16) (LC).

Discussion

In most cases, these species are widely distributed in central-southern Italy, and their presence in Basilicata was not known due to a simple lack of observation. However, of particular interest among the species collected is the discovery of *Brachydontium trichodes*, a Mediterranean mountain species found in the mountain belt below the tree line, where deciduous hardwoods predominate. In Pollino Park the species was found on rocks near Lago Duglia (1375 m a.s.l.); in Italy it has only been reported from Lombardy in Valganna (Garovaglio 1843) and from Emilia-Romagna in the Tuscan-Emilian Apennines (Velluti 1993) (Fig. 5A). *B. trichodes* grows mainly on shady rocks by streams in mountainous areas, although it can also grow on other soft and friable rocks. It usually grows on vertical or overhanging rock faces but is sometimes found on small pebbles.

Another interesting discovery is *Grimmia alpestris*. This species has been reported in Italy from many localities in the regions of the Alpine Arc, in Sardinia from M.te Gennargentu (Massari 1897) and in Sicily from Puglisi (2009) from M.te Etna. It is a boreo-montane species collected on ophiolitic rocks of Timpa delle Murge (between Case del Conte and La Catusa spring, 1216 m a.s.l.).

The ophiolitic rocks of Timpa delle Murge are also the preferred substrate for other species that are very rare from a chorological point of view and that find in this habitat

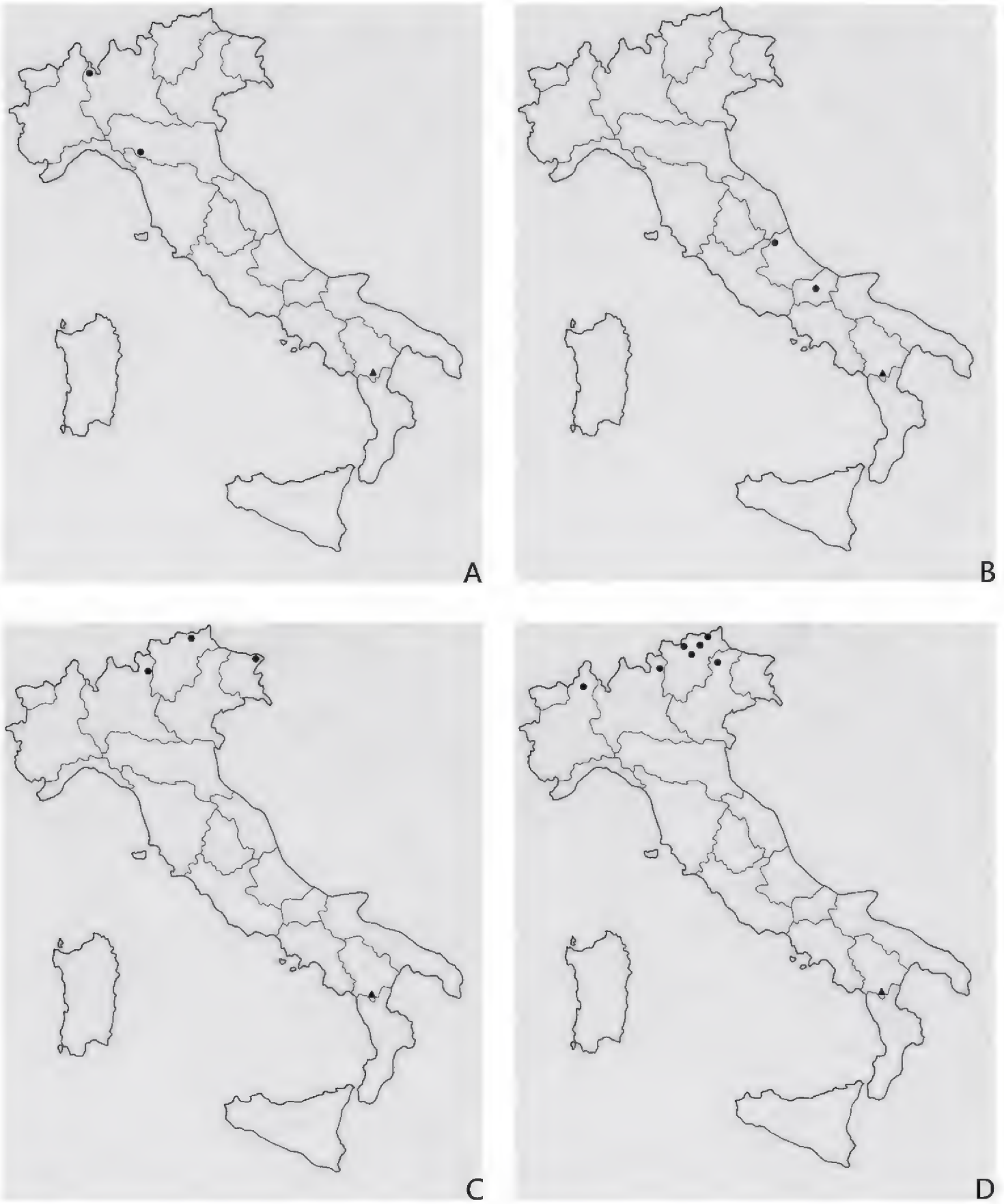

Figure 5. Distribution maps in Italy of **A** *Brachydontium trichodes* (F.Weber) Milde **B** *Lescuraea saviana* (De Not.) E.Lawton; C. *Tortula laureri* (Schultz) Lindb.; D: *Herzogiella striatella* (Brid.) Z.Iwats.

the southernmost refuge of their distribution area (Fig. 6). Among these we can mention *Grimmia funalis* and *Schistidium papillosum*.

Grimmia funalis is a subarctic-subalpine species distributed in the Alpine and Apennine regions of Italy and Sardinia (Herzog 1909); it grows on a variety of rocks, but usually showing some degree of basal richness, on dry to periodically wet rocks, ledges and scree, usually above 300 m.

Figure 6. Ophiolitic rocks outcrops with *Ilex aquifolium* shrubs.

Schistidium papillosum is an arctic alpine species distributed in Val d'Aosta (Schumacker et al. 1999), Piedmont (Blom 1996), Trentino-Alto Adige (Blom 1996; Düll-Wunder 2008; Hofbauer and Dickson 2020), Veneto (Scortegagna 2021), Liguria (Poponessi et al. 2013) and Tuscany (Blom 1996). The species grows on rocks, rarely on bark, in mesic habitats at low to high altitudes (0–2000 m).

The highest peaks of the Pollino Massif are a refuge for some species that have a very sporadic distribution in Italy, being mainly found on the highest peaks of the Alps and the Apennines. Some species are found in the Serra di Crispo and Piano Jannace, at altitudes between 1950 and 2050 metres above sea level. Among these, we remember *Lescuraea saviana*, a subalpine species collected on the bark of *Pinus leucodermis* in Serra di Crispo (2050 m a.s.l.). This species grows mainly at the base of trunks, boulders, outcrops and on soil between 600 and 2500 m a.s.l. In Italy it is only reported in Molise (Giacomini 1938) and in Abruzzo (Mastracci and Düll 1991) in the Laga mountains (Fig. 5B).

Timmia norvegica grows on the rocks of the Serra di Crispo (2050 m a.s.l.). It is a subarctic-subalpine species reported from the regions of the Alpine Arc and from Abruzzo (Mastracci and Düll 1991). *T. norvegica* grows in a fine turf of other mosses and herbs on dry or damp, base-rich rock ledges at high altitudes. It prefers calcareous schist rocks to limestone and basalt.

Another subarctic-subalpine species is *Tortella fragilis*, collected on the Serra di Crispo soil and reported from many locations of the regions of the Alpine arc, from Emilia-Romagna (Fitzgerald and Bottini 1881) and Abruzzo (Aleffi et al. 1997). Rarely fruiting, capsules ripen in summer. Grows on substrates that are probably drained for part of the year, acid or calcareous rocks, dry meadows, logs or peaty humus in springs, fens, open sands on lake shores, snow-covered edges; low to high altitudes (0–3600 m).

Tortula laureri was collected on the rocks of Piano Jannace (1926 m a.s.l.). It is an arctic alpine species that has only been reported in Italy in the second half of the 19th century from Lombardy at M.te Tonale (De Notaris 1869), Trentino-Alto Adige at M.te Gries (Juratzka 1882) and Friuli-Venezia Giulia at Mangart (Wallnofer 1888) (Fig. 5C). The species prefers to grow on rocky outcrops, on soil or soil over rocks, on mineral soils and on infertile peat.

It is worthy of note that the bryoflora of Lucania is home to a plethora of species that are new to science and extremely rare in Italy. One such species is *Herzogiella striatella*, which was collected on a stump of *Fagus sylvatica* along the Pietra Castello path towards Lago Fondo (1876 m a.s.l.). It is an arctic-montane species that has been documented in various locations within Italy. These include Piedmont at Campello-Monti (Levier 1905), Lombardy at Passo del Tonale (De Notaris 1869), Trentino-Alto-Adige at Forcella Sarentina (Heufler 1851), Cima Paganella and Paneveggio (Venturi 1879) and Val Passiria (Schäfer-Verwimp et al. 2021), as well as from Veneto at Valle Ornella (Lorentz and Molendo 1867) (Fig. 5D). It typically inhabits montane districts, growing on peaty soil in crevices amongst boulders at high altitudes. However, it can also be found in woodlands at lower altitudes.

Rhizomnium magnifolium is another arctic-montane species that has been observed growing on soil along the river of Lago Duglia (1387 m a.s.l.). It has also been reported in the Alpine regions and in Emilia-Romagna. (Gerdol and Tomaselli 1988). *Rhizomnium magnifolium* is a species that is typical of wet, base-poor, montane habitats, including sheltered gullies and snowbeds. However, it is also known to occur in mildly base-rich flushes down to approximately 400 metres altitude in the hills.

Regarding the conservation status of these taxa, all observed species are classified as LC (Least Concern) in the Red List of Italian Bryophytes (Puglisi et al. 2023, 2024) with the exception of *Brachydontium trichodes* considered Endangered (EN) in Italy, *Grimmia alpestris* and *Schistidium papillosum* considered Vulnerable (VU), and *Grimmia tergestina* and *Lewinskya shawii* considered Near Threatened (NT). Some of these species have been found on ophiolitic rocks demonstrating the importance of this particular type of environment.

Conclusion

The discovery of 41 species hitherto unknown to the Basilicata region, gathered during an excursion by the Italian Botanical Society's Working Group for Bryology in the Lucania sector of the Pollino National Park, serves to reinforce the notion that vast areas of Italian territory remain entirely uncharted or only partially documented from a

bryological perspective. Consequently, there is a pressing need to intensify research efforts in these regions with a view to more accurately quantifying the Italian bryophyte heritage and investigating the biogeographical, chorological and ecological attributes of each species. Furthermore, these findings reinforce the significance of protected areas for the conservation of biodiversity, even in the context of less-studied taxonomic groups such as bryophytes.

The research has identified a group of boreal and arctic-alpine species that have their southern biogeographical limit in the Pollino Massif. These include *Grimmia alpestris*, *G. funalis*, *Schistidium papillosum*, *Lescuraea saviana*, *Timmia norvegica*, *Tortella fragilis*, *Tortula laureri*, *Herzogiella striatella* and *Rhizomnium magnifolium*. These species covered the Italian Peninsula during the ice ages and remained isolated as relics in the postglacial period. This is corroborated by the presence of a notable assemblage of boreal and arctic-alpine species within the phanerogamic flora, which have established refugia on the highest peaks of the Apennine chain.

The presence of habitats with highly diverse ecological characteristics also results in a notable increase in biodiversity. One illustrative example is the occurrence of ophiolitic rock outcrops, which host a distinctive bryophytic flora comprising numerous rare saxicolous species belonging to the genera *Grimmia*, *Hedwigia*, *Schistidium* and *Ptychostomum*. These species demonstrate a high degree of adaptation to the arid and particularly exposed nature of this habitat.

The floristic richness of the Pollino massif, despite remaining relatively unknown and understudied, is of considerable importance. This is due to the notable variety of environments and their altitudinal differences. It is therefore crucial to extend the exploration of the Pollino massif to the Calabrian side of the Park. This will facilitate a more detailed and comprehensive understanding of the bryophytic flora of the region within the broader context of the national territory and the Mediterranean basin.

Acknowledgements

Financial support by Fondazione per la Flora Italiana for the publication fee is gratefully acknowledged.

References

Aleffi M, Cogoni A, Poponessi S (2023) An updated checklist of the bryophytes of Italy, including the Republic of San Marino and Vatican City State. Plant Biosystems 157(6): 1259–1307. https://doi.org/10.1080/11263504.2023.2284136

Aleffi M, Cortini Pedrotti C, Schumacker R (1997) Flora briologica dei Monti della Laga (Italia centrale). Webbia 52(1): 1–41. https://doi.org/10.1080/00837792.1997.10670631

Avolio S (1996) Il Pino Loricato. Ed. Prometeo, Castrovillari.

Bernardo L (1995) Fiori e piante del Parco del Pollino. Ed. Prometeo, Castrovillari.

Bernardo L, Di Pietro R, Adamo M (2000) Segnalazioni floristiche italiane: *Caltha palustris* L., specie nuova per la Basilicata. Informatore Botanico Italiano 32(1–3): 52.

Blasi C (2006) Il Fitoclima d'Italia. In: Blasi C (Ed.) Completamento delle Conoscenze Naturalistiche di base, Carta delle Serie di vegetazione d'Italia, scala 1:250.000. GIS Natura, Roma.

Blom HH (1996) A revision of the *Schistidium apocarpum* complex in Norway and Sweden. Bryophytorum Bibliotheca 49: 1–333.

Bonardi G, D'Argenio B, Perrone V (1988) Carta geologica dell'Appennino meridionale (scala 1:250.000). C.N.R., Roma.

Bonin G (1969) A propos de quelques endémiques de la flore orophile d'Italie du Sud préséntes au Mont Pollino (Calabre). Annales de la Faculté des Sciences de Marseille 42: 131–138.

Bonin G (1972) Première contribution a l'étude des pelouses mésophiles et des groupements hygrophiles du Monte Pollino (Calabre). Phyton 14: 121–136.

Bottini A (1909) Spigolature briologiche. Bollettino della Società Botanica Italiana 4: 103–118.

Bottini A, Arcangeli G, Macchiati L (1883) Prima contribuzione alla flora briologica della Calabria. Atti della Società Crittogamologica Italiana 3: 105–119.

Bottini A (1894) Note di briologia italiana. Nuovo Giornale Botanico Italiano 1: 249–258.

Brizi U (1890) Addenda ad floram italicam. Note di Briologia italiana. Malpighia 4: 262–282, 350–362.

Casas C, Brugués M, Cros RM, Sérgio C [Eds] (2006) Handbook of mosses of the Iberian Peninsula and the Balearic Islands. Institut d'Estudis Catalans, Barcelona, 1–385.

Casas C, Brugués M, Cros RM, Sérgio C, Infante M [Eds] (2009) Handbook of liverworts and hornworts of the Iberian Peninsula and the Balearic Islands. Institut d'Estudis Catalans, Barcelona, 1–176.

Cavara F, Grande L (1913) Esplorazioni botaniche in Basilicata. Bullettino Orto Botanico Regia Università di Napoli 3: 353–451.

Colacino C, Evangelista E, D'Avella C, Verova F (2013) Nuove segnalazioni per la brioflora della Basilicata. Informatore Botanico Italiano 45(2): 209–212.

Cortini Pedrotti C (2001) Flora dei muschi d'Italia. Sphagnopsida, Andreaeopsida, Bryopsida (I parte). A. Delfino Editore, Roma, 1–817.

Cortini Pedrotti C (2005) Flora dei muschi d'Italia. Bryopsida (II parte). A. Delfino Editore, Roma, 1–418.

De Notaris G (1869) Epilogo della Briologia Italiana. Co' tipi del R. I. de' Sordo-Muti, Genova.

Di Pietro R (2009) Observations on the beech woodlands of the Apennines (peninsular Italy): an intricate biogeographical and syntaxonomical issue. Lazaroa 30: 89–97.

Di Pietro R (2010) Phytosociological features of *Sesleria calabrica* (Poaceae), an endemic species to Pollino-Orsomarso mountains (southern Italy). Acta Botanica Gallica 157(3): 539–554. https://doi.org/10.1080/12538078.2010.10516229

Düll-Wunder B (2008) Die Moosvorkommen am Schlern (Südtirol, Italien) (bearbeitet im Rahmen des Projektes "Habitat Schlern/Sciliar"). Gredleriana 8: 95–124.

Fitzgerald C, Bottini A (1881) Prodromo della briologia dei bacini del Serchio e della Magra. Nuovo Giornale Botanico Italiano 13: 23–121.

Garovaglio S (1843) Catalogo di alcune crittogame raccolte nella Provincia di Como e nella Valtellina. Parte III. Pavia.

Gavioli O (1934) Ricerche sulla distribuzione altimetrica della vegetazione in Italia. II. Limiti altimetrici delle formazioni vegetali in alcuni Gruppi dell'Appennino Lucano. Nuovo Giornale Botanico Italiano 41(3): 558–673. https://doi.org/10.1080/11263503409437329

Gerdol R, Tomaselli M (1988) Phytosociology and ecology of stream vegetation in the summit region of the northern Apennines. Bollettino del Museo di Storia Naturale della Lunigiana 6–7: 89–93.

Giacomini V (1938) Revisione delle briofite dell'Italia meridionale appartenenti all'Erbario A.G. Gasparrini. Parte I: Muschi. Atti dell'Istituto Botanico "Giovanni Briosi" 10: 305–319.

Giordano GC (1871) Prima contribuzione alla flora briologica napolitana. Bullettino Naturalisti Medici 2: 10–16.

Giordano GC (1879) Pugillus muscorum in agro neapolitano lectorum. Atti della Società Crittogamologica Italiana 22: 49–102.

Giordano GC (1892) Nuova contribuzione di Muschi meridionali "Addenda ad pugillus muscorum in agro neapolitano lectorum". Bollettino della Società Botanica Italiana 1: 39–46.

Herzog Th (1909) Über die Vegetationsverhältnisse Sardiniens. Botanische Jahrbücher für Systematik 42: 341–436.

Heufler LR [Von] (1851) Die Laubmoose von Tirol. Sitzungsberichte Kaiserlichen Akademie der Wissenschaften. Mathematisch- Naturwissenschaftliche Classe, 1–32.

Hodgetts NG, Söderström L, Blockeel TL, Caspari S, Ignatov MS, Konstantinova NA, Lockhart N, Papp B, Schröck C, Sim-Sim M, Bell D, Bell NE, Blom HH, Bruggeman-Nannenga MA, Brugués M, Enroth J, Flatberg KI, Garilleti R, Hedenäs L, Holyoak DT, Hugonnot V, Kariyawasam I, Köckinger H, Kučera J, Lara F, Porley RD (2020) An annotated checklist of bryophytes of Europe, Macaronesia and Cyprus. Journal of Bryology 42(1): 1–116. https://doi.org/10.1080/03736687.2019.1694329

Hofbauer WK, Dickson JH (2020) Mosses and Liverworts of Tyrol. Especially those connected to the Iceman. Alpine Forschungsstelle Obergugl 5: 1–236.

Juratzka J (1882) Die Laubmoosflora von Osterreich-Ungarn. Vienna.

Levier E (1905) Appunti di briologia italiana. Secondo elenco (Musci frondosi). Bollettino della Società Botanica Italiana 5: 145–158.

Lorentz PG, Molendo L (1867) Cronaca della Briologia Italiana per G. De Notaris. I 1866. II 1867. Flora 26: 401–409; 27: 425–430; 28: 441–448; 29: 449–460. Berichtigung, 511–512.

Massari M (1897) Contribuzione alla briologia pugliese e sarda. Nuovo Giornale Botanico Italiano 4: 317–352, 357–385.

Mastracci M, Düll R (1991) Le raccolte delle escursioni del Congresso Internazionale di Briologia. In: Mastracci M (Ed), Atti del Congresso Internazionale di Briologia (L'Aquila, 15–26 luglio 1991), 93–124.

Micheletti L (1895) Flora di Calabria. Prima contribuzione (Muscinee). Bollettino della Società Botanica Italiana 6: 169–176.

Pasquale GA (1850) Bryologiae Neapolitanae commentariorum. Rendiconti dell'Accademia delle Scienze della Società Reale Borbonica 9: 115–125.

Paton JA [Ed.] (1999) The Liverwort Flora of the British Isles. Harley Books, IUCN. Colchester, 1–626. https://doi.org/10.1163/9789004285385

Poponessi S, Mariotti M, Venanzoni R, Aleffi M (2013) Notulae Cryptogamicae 6 (30–34). Informatore Botanico Italiano 45(1): 112–113.

Puglisi M (2009) New interesting records to the moss flora of Sicily (Italy). Cryptogamie, Bryologie 30(3): 395–398.

Puglisi M, Privitera M, Di Pietro R (2009) New interesting bryophyte records from the Pollino National Park (southern Italy). Flora Mediterranea 19: 5–9.

Puglisi M, Aleffi M, Cogoni A, Privitera M (2014) The top of the Pollino massif (southern Italy), an important refuge area for noteworthy mosses. Plant Biosystems 148(4): 869–873. https://doi.org/10.1080/11263504.2014.949327

Puglisi M, Kürschner H, Privitera M (2016a) The mountain and high-mountain bryophyte vegetation of the Pollino National Park (Southern Italy): syntaxonomy and ecology. Nova Hedwigia 103(3–4): 385–413. https://doi.org/10.1127/nova_hedwigia/2016/0362

Puglisi M, Campisi P, Dia MG, Privitera M (2016b) New interesting moss records from the Pollino National Park (Southern Italy). Flora Mediterranea 26: 145–150. https://doi.org/10.7320/FlMedit26.145

Puglisi M, Privitera M (2018) New and noteworthy records of mosses from Italian national and regional Parks. Plant Biosystems 152(4): 604–607. https://doi.org/10.1080/11263504.2017.1320314

Puglisi M, Campisi P, Aleffi M, Bonini I, Cogoni A, Dia MG, Miserere L, Privitera M, Tiburtini M, Poponessi S (2023) Red-list of Italian bryophytes. 1. Liverworts and hornworts, Plant Biosystems 157(4): 746–757. https://doi.org/10.1080/11263504.2023.2200791

Puglisi M, Campisi P, Aleffi M, Bacilliere G, Bonini I, Cogoni A, Dia MG, Miserere L, Privitera M, Tiburtini M, Poponessi S (2024) Red-list of Italian bryophytes. 2. Mosses, Plant Biosystems 158(5): 1031–1056. https://doi.org/10.1080/11263504.2024.2386330

Schäfer-Verwimp A, Mair P, Kiebacher Th, Porley RD, Ahrens M (2021) Neue und bemerkenswerte Moosfunde für Südtirol (Provinz Bozen, Italien). II. Gredleriana 21: 5–48.

Schumacker R, Soldán Z, Aleffi M, Miserere L (1999) The bryophyte flora of the Gran Paradiso National Park (Aosta Valley and Piedmont, Italy) and its immediate surroundings: a synthesis. Lejeunia 160: 1–107.

Scortegagna S (2021) Segnalazioni floristiche venete: Briofite 4-31. Natura Vicentina 22: 123–137.

Smith AJE (1991) The liverworts of Britain and Ireland. Cambridge University Press, Cambridge, 1–378.

Smith AJE (2004) The moss flora of Britain and Ireland. 2nd edn. Cambridge University Press, Cambridge, 1–1026. https://doi.org/10.1017/CBO9780511541858

Velluti C (1993) Contributo all'analisi fitogeografica dei faggeti e della vegetazione ipsofila del versante padano dell'Appennino settentrionale. Piante vascolari, briofite e licheni. Tesi di Dottorato di Ricerca in "Geobotanica", VI Ciclo, Università di Pavia, Italia.

Venturi G (1879) Bryineae ex regione italica Tirolis, Tridentina dicta. Revue Bryologique et Lichénologique 6: 49–62.

Wallnofer A (1888) Die Laubmoose Kärntens. Jahrbuch der Naturhistorische Museum 20: 1–155.

Zodda G (1909) Notizie briologiche sull'Italia meridionale. Malpighia 23: 23–54.

Zodda G (1910) Sulle epatiche dell'Italia meridionale e della Sicilia conservate negli erbari del R. Orto Botanico di Napoli. Bullettino Orto Botanico Regia Università di Napoli 2: 313–322.

Zodda G (1913) Studio briogeografico sulla Basilicata e catalogo delle Briofite di questa provincia fin oggi conosciute. Nuovo Giornale Botanico Italiano 20: 155–232.